

until it's needed. Hydrogen can also be transported (like electricity) to locations where it is needed.

The widespread adoption of hydrogen fuel is hindered by higher cost of hydrogen compared with usual liquid and gaseous fuels, the lack of necessary infrastructure. An interim solution could be a mixture of traditional fuels with hydrogen. Hydrogen can be used to improve the ignitability of lean mixtures in combustion engines running on conventional fuels.

#### REFERENCES:

1. The World's #1 Renewable Energy Network for News, Information, and Companies // <http://www.renewableenergyworld.com/hydrogen/tech.html>

Научный руководитель: В.В. Воробьева, к.ф.н., доцент каф. ИЯЭИ ЭНИИ ТПУ.

### **THE COMPARISON OF COMPLEXITIES OF THE CHINESE AND RUSSIAN LANGUAGES ON THE EXAMPLE OF TERMINOLOGY OF CHEMISTRY**

Ж.К. Иванова

Томский политехнический университет  
ИСГТ

Many linguists are wondering whether it is possible to objectively assess the complexity of languages without attracting speakers of a particular language. If so, what criteria can be used to do this? Alexander Pipersky, candidate of Philology, assistant professor of the Institute of Linguistics of the Russian State University for the Humanities, gives the example with the Martian who came to our planet and needs to learn a human language - which language would be easier for him then, and which one would be more difficult [1]? Linguists in the process of studying language complexity try to answer this question.

Chinese is certainly one of the most complex languages in the world: tonality, a large number of synonyms, homonymy, hieroglyphics, high-speed speech of speakers, 10 dialect groups, etc., but in every even the most complex language there are also advantages that can be identified in comparison with another language.

If you take a certain professional sphere and look at the terminology of this field in Chinese, you can see that although Chinese characters are difficult to write, but their graphical content carries so much information that even if some term is absolutely unfamiliar and highly specialized, then its meaning and nature can be understood simply by looking at the characters in its composition. In this respect, the terminology in Russian is harder to perceive and understand than in Chinese, since it uses mostly those terms that are used only in a professional context, while most of hieroglyphs in Chinese terms are commonly used in ordinary life.

Let's compare the terminology of Chinese and Russian languages by the example of chemical terms, where there are dozens of incomprehensible words and expressions in the Russian language, the origin and nature of which are difficult to guess, since most of them come from the words of the Greek and Latin languages.

1. **One-component terms:** The term 氢 "hydrogen". Let's examine what in general this term means in Russian. Hydrogen is a light, colorless gas. Much of this definition is already contained in the hieroglyph, since the key 气 means "gas", and the lower two keys are part of the word "light", and the word is completely in tune with the word "hydrogen" - qīng. The Russian term "hydrogen" also carries some information, if you disassemble it into the components of "water" + "genus". After all, everyone knows that, according to the laws of chemistry, hydrogen as a chemical element in conjunction with oxygen forms water, but this information is secondary in comparison with the information given by the Chinese term "light gas".
2. **Two-component terms:** The term 加 嗅 "odorization" (from Latin odor - "smell"): add + smell. In the dictionary, the term "odorization" is defined as giving (gas) a characteristic smell. As we see, the translation of the hieroglyphs in the term ideally reflects the whole nature of the term.
3. **Three-component terms:** The term 异构 化 "isomerization": isomer + transformation. 异构 "isomer": different + structure. It turns out that there are particles, involved in a certain transformation, being different in structure. According to the dictionary, isomers are substances that have the same qualitative and quantitative composition, but different structure and, therefore, different characteristics.
4. **Four-component terms:** The term 无 定形 碳 "amorphous carbon". Not everyone can understand the meaning of the word "amorphous," but in the Chinese term everything looks quite clear: there is no + established + form + carbon, literally translating as "carbon without a fixed form." And now look at the original definition of this term - amorphous carbon - "a state of carbon with a disordered structure."
5. **Multicomponent terms:** The term 非 压缩 氢气 "uncompressed hydrogen". Let's divide this term into its components: no + pressure + compress + hydrogen + gas. In the Russian version of this term, we face a word of Latin origin "compression", which means "compression of gas under the influence of external forces to reduce its volume, increase pressure and temperature." Of course, many ordinary people know the term "compression", but yet again we have a Russian term of Latin origin, which complicates its perception.

Thus, using the example of these chemical terms, we can observe the comparative easiness of understanding Chinese terms and the complexity of understanding their analogues in Russian.

In addition to the comparison of terms in this work, two experiments were also carried out to reveal the essential difficulties and advantages of the Chinese and Russian languages.

In the first experiment, a Chinese text on chemicals in food was selected. The text was translated into Russian. Then a couple of Chinese students wrote at dictation the text in Chinese and Russian students – the text in Russian. The objective of the experiment was to determine the main difficulties that arise in the process of writing in these languages.

**Difficulties of the Chinese language, revealed during the first experiment:**

1. The relatively long time of writing a small piece of text - a little more than half a page in 23 minutes.
2. The problem with punctuation and selection of paragraphs, because of what the text looks unstructured.
3. The big difference between classical written and spoken Chinese.
4. Spelling of hieroglyphs – Chinese native speakers themselves forget how to write some hieroglyphs or certain lines of hieroglyphs.
5. Homonymy of the Chinese language - because of the identical spelling of the words, some characters were written wrong in the text (子 zǐ (child) and 紫 zǐ (purple), 成 chéng (become) and 呈 chéng (have a look), 攝入 shè rù (absorption) 涉入 shè rù (penetrate), 症 zhèng (disease) and 征 zhēng (syndrome)).
6. Confusing words that are only partially consonant and partially similar in spelling (即 jí (even if) and 及 jí (i), 无论 wúlùn (despite) and 不论 bùlùn (regardless of)).
7. Words are not separated on the letter from each other by spaces, as in Russian, because of which it is sometimes difficult to determine the boundaries of words.

**Difficulties of the Russian language, revealed during the first experiment:**

1. Complexity of grammatical forms, because of which it is easy to confuse letters in endings, roots or suffixes of words, even simply by inattention (Естественный и натуральные ароматизаторы, Продукты питания).
2. Fast fatigue in writing complete words without shortening words, where it's possible.
3. Voiceless / voiced consonants at the end of the word - the need to check the spelling of words by changing the form of the word, or simply memorizing the rules (циннамальдегид, вместо циннамальдегид).
4. A large number of words of Latin and Greek origin (flavor, cinnamaldehyde, vanillin, orchid, sodium glutamate, etc.). This problem is particularly relevant to chemical terms in the Russian language, where each term has a Latin or Greek origin and therefore causes difficulties in understanding both in speech and in writing.

In the second experiment the students of the both sides were asked to read the same texts in order to reveal some difficulties in oral speech of Chinese and Russian.

**The difficulties of the Chinese language, revealed during the second experiment:**

1. One character can be read in different ways and there are no clear rules for this or that variant of reading, you can check only in the dictionary (For ex-

ample, in the word from the text 差別 chābié, which means "difference", in the hieroglyph 差 except for reading chā there is still a few readings: chà, chāi, chài, cī, cuō, jiē. For example, in the word 参差 cēncī "asymmetrical" this hieroglyph is read as cēn, and in the word 出差 chūchāi "business trip" the hieroglyph is read as chāi).

2. Homonymy of words.
3. Tones that involve a large articular work.
4. Great semantic significance of tones - if the tone changes, then the writing of the hieroglyph of the word and its meaning change dramatically. Very often, native speakers themselves during the speech clarify each other the meaning of a word.

**Difficulties of the Russian language, revealed during the second experiment:**

1. Voiceless / voiced consonants at the end of the word: due to the fact that voiced consonants at the end of the word are deafened, then on the letter it is easy to make a mistake with writing (the Russian student made a mistake by writing not циннамальдегид, but циннамальдегит, that in oral speech, she would have incorrectly remembered the term and wrongly used it later, for example, she would then say «циннамальдегита, циннамальдегиту», etc.).

Of course, it is impossible to consider and point out all the difficulties of the Chinese and Russian languages, since these two language systems are relatively complex and large-scale. However, from the data obtained in the course of two experiments, we can see that the Chinese language has much more difficulties than Russian. Nevertheless, this does not mean that the Russian language is easier, on the contrary, from the point of view of the grammatical structure, the Russian language is much more complicated, as the results of experiments have shown, but from the point of view of clarity and precision of information presentation, from the point of view of the most detailed expression of meaning for the most full understanding or translation into other languages, the Russian language is easier.

The grammatical categories of the Russian language, although difficult to use, yet still contribute to the most detailed description of a phenomenon, which is very important in the narrowest and most precise areas of knowledge, where it is necessary to describe the smallest detail of what is happening, for example, during experiments on chemistry or surgical operations.

Chinese is easier to understand the meaning of individual words, but not of a whole sentence or text. Especially it concerns any specialized terms in certain areas, for example, in chemistry. Russian is harder to understand technical terms, since most such words are borrowed from Latin and Greek. On the other hand, sometimes borrowed words can be useful for a better understanding of the meaning, since they can express a more specific meaning, which is very important in narrow areas of knowledge.

## LITERATURE:

1. Piperski A. Language complexity [Electronic resource]. - Access mode: <https://postnauka.ru/video/54750> -23.03.2017

Scientific adviser: Y. Kobenko, Dr. of Philology, professor of Department of Foreign Languages of National Research Tomsk Polytechnic University.

## ENERGY OF THE FUTURE

A. Lazarenko

Tomsk Polytechnic University

Institute of Power Engineering, group 5061

Mankind has long pondered the question of what the energy of the future will be. The problem of global energy research is that it is necessary to take into account a greater number of factors affecting the production and consumption of energy resources. The world has accumulated considerable experience in researching the future of world energy.

Technological and scientific discoveries directly affect the world energy consumption and production. Research is constantly being carried out to improve energy efficiency. Analysis of technological trends shows that humanity is on the verge of an energy revolution. Today's energy is based on burning fossil fuels with a fairly low efficiency. The energy of the future is based on the use of renewable energy sources and active promotion of nuclear energy, efficient use of energy resources. The main directions of the energy revolution are the widespread dissemination of energy saving technologies, the integration of energy into the technosphere, the decentralization of energy, the creation of energy information systems, an "energy efficient house" and an "energy efficient city".

Table 1. World primary energy consumption by a scenario, million tones

	2010	2030	2050	2030	2050	2030	2050
Oil	3882	4627	5018	4441	4188	3641	2757
Gas	2653	3952	4522	3306	3483	3292	3092
Coal	3278	4617	4487	3209	1794	3526	1812
Nuclear	626	776	824	512	349	1335	2333
Biomass	650	600	600	600	600	300	200
Hydro	572	729	952	729	952	729	952
New re- newables	210	1040	1835	1481	3019	1860	5846
Total	11871	16342	18239	14279	14386	14683	16993

In this scenario, the main role will be taken by nuclear and renewable energy. By 2030, nuclear power can double, and by 2050 – become four times compared with the current level. The basis for such growth will be an accelerated transition to standard 3- and 4-generation reactors, as well as to fast neutron reactors. This will solve the uranium problem and the problem of used nuclear fuel. Renewable energy will